REMARKS

This amendment after a final rejection should be entered because the claims have been amended to overcome objections first stated in the rejection. Entry of the amendment should place this application in better condition for appeal, if needed.

The objections to claims 16 and 17 have been overcome by amendment.

Claims 16 is amended to specify that "wherein the estimated spectra of the endmembers after the stopping condition is met are regarded as the identified endmember spectra values from the multispectral image data." Similarly, claim 17 is amended to specify that "wherein the estimated mixing proportions of each data value after the stopping condition is met are regarded as identified proportions of each of the identified endmember spectra values present in each data value of the multispectral image data." These amendments should overcome the objections to claims 16 and 17.

The rejection of claims 1, 5, 12, 13 and 14 as being indefinite is traversed. The residual sum of squares (RSS) is a term well known to those skilled in the field of the invention to be a value which represents a discrepancy or error between the observed data values and modeled values.

The model of an embodiment of this invention is given by equation (1) in paragraph 28. The model is fitted to the data using a regularized least squares minimization technique to produce a regularized RSS. In an embodiment of this invention the calculation for the regularized RSS is given in equation (3) in paragraph 32. In this case, the observed data is multispectral image data ($\mathbf{x}_j$), while the unknown

variables (endmember spectra (%) and the mixing proportions in each pixel in the image (**P**)) are estimated as part of the regularized least squares minimization technique. This is reflected in paragraphs 28 to 34 of the specification.

The RSS is regularized by a constraining term such that the solution converges to a simplex of appropriate size. A simplex obtained by shrink-wrapping (all the data cloud is within this simplex) is too big because it is too sensitive to noise. A simplex wholly contained within the data cloud is too small as it may not find the vertices that do not lie within the data. In this case the constraining term is a measure of the size of the simplex (hejT De, in the embodiment of equation (3)).

Claim 1 is amended to specify that "wherein the regularized residual sum of squares is reflective of a difference between the multispectral image data and a calculated value which is based on the estimated mixing proportions and estimated spectrum of each endmember."

This amendment is in response to the queries in the Action of "what is meant by residual sum? What variables make up this residual sum? How is the residual sum related to the estimation of the mixing proportion and estimation of the spectrum of each endmember?" The residual sum of squares is reflective of the difference between the multispectral image data is a calculated value which is based on the estimated mixing proportions and estimated spectra.

Regarding the Examiner's query relating to "size of the simplex". The applicant submits that the term "a measure of the size of the simplex" has a clear meaning. The

Concise Oxford Dictionary 9th Edition defines "size" to mean "the relative bigness or extent of a thing, dimensions, magnitude." In this context, size is readily understood and a measure of the size is also readily understood. The size of a two dimensional shape can be understood, in terms of its magnitude, and yet it can be measured a number of ways. Importantly, there is no need to specify the mode of measuring the size in order to understand the meaning of measure of the size. For example, in the case of a rectangle one measure is the area, another is dimensions (height and width), and yet another is the perimeter. Some measurements of the rectangle are calculable from others, for example, area from dimensions or perimeter from dimensions, but some may not be, for example dimensions from area alone. In the case of the multidimensional simplex, the meaning of a measure of the size of the simplex is readily understood to be a measurable indication of the relative magnitude of the object. The mode of measurement can take a number of forms. For example, the measure could be the volume of the simplex, the surface area, the distance of each vertex from an origin, or the distances between the vertices. It is unnecessary to provide a precise form of the measure. Some forms of measurement will have advantages over others, but the skilled person need not be limited to any one.

In response to "what is meant by size of the simplex? Is the size considered to be a volume? Is the size considered to be an area? Diameter? Number of elements?", the normal English meaning of measure and size should be taken. The enclosed volume, surface area dimensions are all valid measurements of the size of the simplex and can be readily understood by the skilled person without further qualification.

The applicant submits that correction is not required as the choice of the form measurement is open to the skilled person, with some methods of measuring the size having some advantages over others. The specification provides a particular example, but is not intended to be limited to this particular method.

The rejection of claims 1, 2, 10, 11, 12, 13, 14, 15, 16 and 17 as being anticipated is traversed.

There is no anticipation because Keshava (see page 48, column 2, paragraph 2) describes a process to:

- "... decompose the complete, end to end mixing problem as a sequence of three <u>consecutive</u> procedures…
- "Dimension reduction: reduce the dimension of the data in the scene...
- "Endmember determination: estimate the set of distinct spectra (endmembers) that constitute the mix pixels in the scene
- "Inversion: estimate the fractional abundances of each mix pixel from its spectrum and the endmember spectra" (emphasis added).

Keshava views these steps as distinct and consecutive. That is, the endmembers are determined and then the fractional abundances (mixing proportions) of each pixel are determined. The endmember determination stage is described from page 50, column 2

under the heading "Endmember Determination" to the end of the first column on page 54. Automated endmember determination is broken down into nonparametric methods, parametric methods and geometric endmember determination. The geometric endmember determination technique described is shrink-wrapping. This process finds the simplex with a specified number of endmembers enclosing the data with the smallest hyper-volume. Keshava on page 54, column 1, paragraph 3 notes that this geometric endmember determination method is "susceptible to outliers and artifacts that may adversely change the shape of the simplex and hence, the estimate of the endmembers". the subsequent inversion process is described at the beginning of the second column on page 54.

The Action asserts that Keshava at page 53, left column, paragraph 3 to right column, paragraph 1, page 54 discloses "wherein the regularized residual sum of squares includes a term which is a measure of the size of the simplex" on the basis of the disclosure of the shrink-wrapping geometric endmember determination technique in combination with the inversion technique described in the first paragraph of the second column of page 54. However, this interpretation of Keshava takes a piece of a first technique, namely the geometric shrink-wrapping process, and arbitrarily combines it with a piece of the distinct subsequent technique of inversion. Keshava does not support this interpretation and does not suggest combining the piece of the first techniques with pieces of distinct and subsequent techniques. Using this incorrect interpretation, the Action incorrectly concludes that Keshava discloses combining these two components

together in a repetitive process of estimating the mixing proportion and estimating the mixing proportions as defined in claim 1.

Specifically, Keshava does not disclose several elements of claim 1 including:

NO REGULARIZED RSS

Claim 1 requires that there is a regularized residual sum of squares. Keshava does not describe regularizing a residual sum of squares (let alone regularizing with a term that is a measure of the size of the simplex).

SIZE OF SIMPLEX DETERMINATION

Claim 1 requires "a measure of the size of the simplex." The shrink-wrapping technique described in Keshava is a geometric process which is not described as involving determining a regularized residual sum of squares. The Keshava shrink-wrapping technique does not disclose "wherein the regularized residual sum of squares includes a term which is the measure of the size simplex" because no regularized residual sum of squares is determined in the shrink-wrapping technique.

Further, the subsequent inversion process described in Keshava is a statistical problem which is not described as involving a measure of the size of the simplex. Thus, the Keshava inversion process does not disclose "wherein the regularized residual sum of squares includes a term which is a measure of the size of the simplex".

As stated by Keshava, the endmember determination and inversion are two quite different things, which are solved independently one after the other. Keshava does not describe taking part of the shrink-wrapping technique for endmember determination and

combining it with part of the least squares method of inversion. If anything, Keshava teaches away from combining endmember determination with an inversion by stating they are a sequence of consecutive procedures. It also teaches away from combining a geometric technique with a statistical technique.

NO REPETITION

Claim 1 requires repeating the estimation steps. This is necessarily the case because of the "repeat ... until" language. This also ensures that the estimation steps are done at least twice in older for there to be a relative change in the regularized residual sum of squares. Undertaking the estimation steps once would not product the required change. Keshava only describes determining endmembers once and then inverting once. Keshava does not repeat these steps. Thus Keshava does not teach or suggest "repeating the estimation of the mixing proportions and estimation of the spectrum of each endmember until a stopping condition is met".

Further, dependent claim 2 comprises a limitation which is not present in Keshava. The passage referred to in the Action simply does not have this limitation.

In relation to dependent claim 10, the Action incorrectly asserts that Keshava discloses utilizing a linear estimation technique and page 48, right column, paragraphs 1 to 5. There was no mention in Keshava of a linear estimation technique on page 48, column 2 of Keshava. The Action confuses the linear mixture model with the linear estimation technique. Models and estimation techniques are not the same.

Dependent claim 12 relates to estimating the mixing which the Action asserts that this feature is described in Keshava at page 53, left column, paragraph 3 to right column paragraph 1, page 54. However, estimating mixing proportions is described from the heading Inversion on second column, page 54. The shrink- wrap technique described on page 53 does not relate to estimating the mixing proportions, and does not anticipate claim 12.

In relation to claim 14 which depends on claims 13, 12 and 1, the Action asserts that Keshava discloses calculating a ratio comprising successive values of minimized regularized residual sum of squares. However, the Action appears to refer to the NNLS algorithm described in the first paragraph in the section "non negativity" on page 55 of Keshava. The NNLS algorithm does not use ratios. Accordingly, applicant respectfully asserts that Keshava does not disclose calculating a ratio comprising successive values of a minimized regularized residual sum of squares.

In relation to claim 15 which depends on claim 13, 12 and 1, the Action asserts that Keshava discloses when the ratio attains its highest value. The applicant cannot find any mention of "ratio" or "tolerance value" in the sections of Keshava mentioned in the Action. Further, Keshava does not describe how the shrink-wrapping process stops.

In view of the foregoing, Keshava does not anticipate claim 1 or its dependent claims 2, 10, 11, 12, 13, 14, 15, 16 and 17.

The Action at para. 13 asserts that claim 1 does not specify that endmembers are to be estimated However claim 1 requires "estimating the spectrum of each endmember...". Accordingly, claim 1 requires that the endmembers are to be estimated.

The Action at para. 13 asserts that the claims do not specify that the measure of the size of the simplex (is) a sum of the square distances between the simplex vertices to regularize the residual sum of squares". However this limitation is in claim 2. The applicant further asserts that this feature is not described in Keshava and that the passage referred to by the Examiner makes no mention of this limitation.

The Action in para. 13 asserts that the claims do not specify an algorithm for estimating the endmembers based on using a term which is a measure of the size of the simplex. However claim 1 requires "estimating the spectrum of each endmember ...when a regularized residual sum of squares determined in the estimation steps ...wherein the regularized residual sum of squares includes a term which is a measure of the size of the simplex". The failure of Keshava to disclose this is covered above.

The Action in para. 13 asserts that the claims do not specify a regularized least squares estimation method. However claim 1 requires finding "a regularized residual sum of squares determined in the estimation steps". Keshava does not disclose this element for the reasons discussed above.

The Action in para. 13 asserts that the claims do not specify that the repetition of the estimation will actually occur. However claim 1 requires "repeating the estimation ... until a stopping condition is met, wherein the stopping condition occurs when a relative

change in...". As noted above this requires the estimation be repeated due to the language "repeat ... until", further the relative change is only available when at least two estimations have occurred.

The Action in para. 13 asserts that Keshava does not state the combining of parametric and geometric teaching is not known. That Keshava is silent about combining the two teachings is no admittance that there are known technologies of combining the two. Rather, it can be inferred that Keshava looked and did not find any such teachings of known technologies. In any event, the silence of Keshava as to a combination of parametric and geometric teachings certainly amounts to a lack of anticipation of the combination of parametric and geometric techniques in the form (language) required by claim 1, as has been outlined above.

All claims are in good condition for allowance. If any small matter remains outstanding, the Examiner is requested to telephone applicants' attorney. Prompt reconsideration and allowance of this application is requested.

The Commissioner is hereby authorized to charge any deficiency, or credit any overpayment, in the fee(s) filed, or asserted to be filed, or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Account No. 14-1140.

Respectfully submitted,

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